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Double cropping wheat and corn in a sub-humid region of China

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Abstract

Double cropping wheat (*Triticum aestivum* L.) and corn (*Zea mays* L.) is common in sub-humid regions of north China. This study was conducted to evaluate the system without irrigation. During the 5-year study period, annual rainfall averaged 638 mm with 387 mm occurring in July, August and September. Water stress often occurred from mid-April to the end of the wheat growing season in early June, and sometimes extended to the early part of the corn season that begins immediately after wheat harvest and ends in mid-September. Wheat and corn grain yields increased as a linear function of evapotranspiration. Average grain yield was 5.2 Mg ha^{-1} for wheat and 5.1 Mg ha^{-1} for corn, with water-use efficiencies, expressed as grain yield per unit of water consumed, of 1.48 and 1.94 kg m^{-3}, respectively. Average precipitation values for the 5-year study period closely parallelled long-term averages, and a probability analysis indicates that yields obtained in the study may be representative of what can be expected over a long period. Therefore, double cropping wheat and corn in this region of China appears highly feasible and results in more than 95% of the precipitation being utilized by evapotranspiration during the growing seasons. Soil water content fluctuates periodically during the year. Phase lags and amplitude decrease with soil depth. One-half of the water utilized by wheat, 175 mm, was furnished by rainfall during the growing season, and the other half was obtained from soil water stored at the time of seeding in mid-October. In contrast, soil water increased during the corn growing season in which rainfall was 384 mm, and evapotranspiration was 263 mm.

Key words: Cropping system; Evapotranspiration; Soil water; Spatial distribution; Water-use efficiency

1. Introduction

Taylor et al. (1983) and Stewart and Nielsen (1990) in extensive reviews of the relationships between water use and crop production conclude that the amount of water available for evapotranspiration (ET) is a major factor determining crop yield. In regions of adequate precipitation, or under irrigated conditions, ET remains relatively constant but water-use efficiency (WUE) has increased because of improved cultivars, fertilizer and pesticide use, and better cultural practices (Viets, 1962). Water-use efficiency is usually defined as yield/ET, with ET the sum of water evaporated from the soil and transpired by the crop between germination and maturity. Water-use efficiency values in water-deficient areas, however, are much more variable, and generally much lower than those in areas where water is not limiting. In water-deficient regions, summer fallow or mulch tillage practices are often used to increase soil water storage that can be used to supplement rainfall during the crop growing season. This can increase water-use efficiency, but often lowers the overall precipitation-use efficiency because of the large amount of water evaporated during the fallow period.

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Interactions between climate, soil, vegetation, and tillage practices influence soil water storage and utilization. Since these factors vary independently within and between years, large variations in soil water content are common. However, certain patterns are common for many regions. To develop cropping systems and management practices aiming at increasing water-use efficiency, the patterns and degree of variability must be determined. The objectives of this study were (1) to determine water-use efficiency for wheat and corn in a sub-humid region of China without supplemental irrigation, and (2) to determine the seasonal pattern of soil water storage and evaluate the capacity of the cropping system to utilize it efficiently in conjunction with seasonal precipitation.

2. Materials and methods

The study was conducted on dryland in a sub-humid region of Gongxian (34.8°N, 113.4°E, elev. 117 m a.s.l.), Henan, China, in 1983–1988. The topography of the region is hilly and the soil is sandy loam with an average field capacity of 0.217 kg kg^{-1}, wilting point of 0.056 kg kg^{-1}, and bulk density of 1.4 Mg m^{-3} in the 0- to 1.3-m layer. Average annual precipitation is 597 mm with a concentration of rainfall during July, August, and September (Fig. 1). Average annual potential evapotranspiration, estimated by the Penman equation (Pei Buxiang, 1989; Jensen et al., 1990), is 1051 mm.

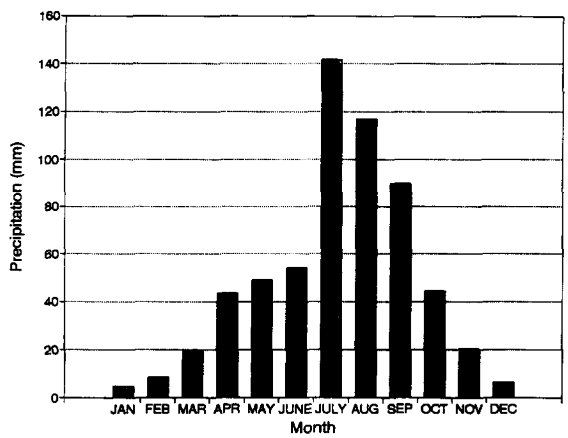

Fig. 1. Distribution of precipitation for 1962–1988, Gongxian, China.

The experiment was conducted in six 2.5 × 8-m plots surrounded by concrete borders to a depth of 1.3 m, thus preventing runon or runoff. Two crops, wheat (*Triticum aestivum* L.) and corn (*Zea mays* L.), were grown each year in each plot for the period between October 1983 and October 1988. Wheat was sown in 0.22-m spaced rows between 10 and 20 October and harvested in early June. Corn was sown in the standing wheat residue as soon as feasible after the wheat was harvested, and harvested between 1 and 15 September. It was sown in 0.42-m spaced rows at a population of 56 000 plants ha^{-1}. Soil water content was measured every 10 days, on the 1st, 11th, and 21st of each month, at depths of 5, 10, 20,..., 130 cm; and at additional 10-cm depths to 200 cm on the 1st day of each month. Measurements were made in three replicates by gravimetric determinations on samples obtained with an auger. A meteorological station was set up in the experimental field to measure factors for calculating potential evapotranspiration.

3. Results and discussion

3.1. Yield and evapotranspiration of wheat and corn

Five years of data for yield, soil water storage, and precipitation are presented in Table 1. Although data for only 5 years are not sufficient to develop relationships between yield and evapotranspiration for a region, definite trends are apparent for both wheat and corn as illustrated in Figs. 2 and 3. Yields increased as a linear function of evapotranspiration, in agreement with previous findings (Howell, 1990). Average grain yield was 5.2 Mg ha^{-1} for wheat and 5.1 Mg ha^{-1} for corn. Evapotranspiration was defined as the amount of precipitation between sowing and harvesting the particular crop plus or minus the change in soil water storage in the 1.3-m soil profile. Runon and runoff were prevented, and percolation below 1.3 m was assumed negligible. Soil water content decreased during the wheat growing season. On average, one-half of the water consumed by wheat, 175 mm, was furnished by precipitation during the growing season and one-half, 178 mm, was derived from soil water stored at the time of sowing. In contrast, soil water storage increased during corn growth. For the 5 years, average precipitation

Table 1
Relationship between yield and growing season evapotranspiration

Dates	Available water at seeding (mm in 1.3 m)	Available water at harvest (mm in 1.3 m)	Evapotranspiration (mm)	Rainfall (mm)	Yield (Mg ha^{-1})
Wheat					
16/10/83 to 31/5/84	253	18	369	134	6.27
7/10/84 to 30/5/85	262	67	399	204	5.82
11/10/85 to 1/6/86	260	86	381	207	5.01
8/10/86 to 1/6/87	86	11	285	210	4.25
18/10/87 to 1/6/88	222	13	329	120	4.69
Average	217	39	353	175	5.21
Corn					
7/6 to 8/9/84	18	229	271	482	5.13
6/6 to 4/9/85	64	177	290	403	6.36
2/6 to 10/9/86	86	80	175	169	0.64
5/6 to 15/9/87	95	178	305	389	7.09
12/6 to 12/9/88	40	244	275	479	6.30
Average	61	182	263	384	5.10

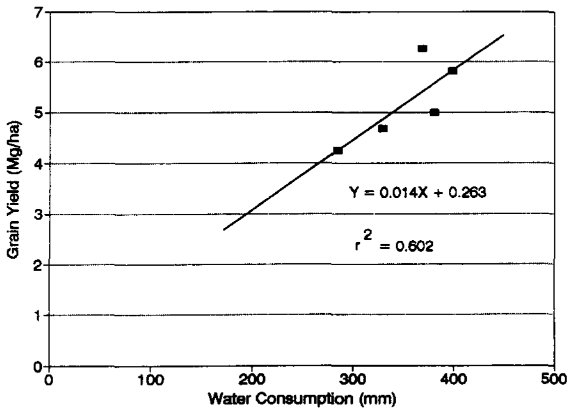

Fig. 2. Relationship between grain yield and evapotranspiration for wheat for five seasons.

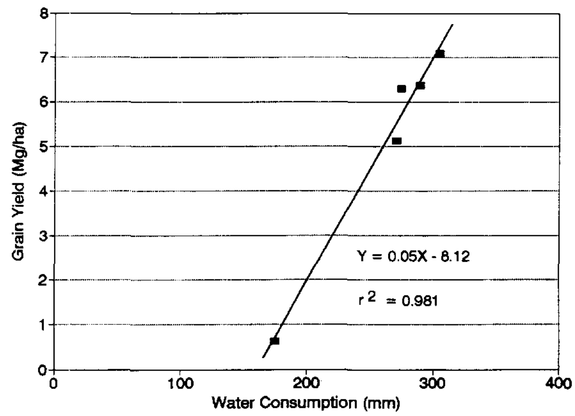

Fig. 3. Relationship between grain yield and evapotranspiration for corn for five seasons.

during the corn seasons was 384 mm and seasonal evapotranspiration was only 263 mm. Therefore, average water storage in the soil profile increased by 121 mm during the corn growing seasons, and was available for use by subsequent wheat crops.

Seasonal evapotranspiration values for corn in this study are low compared with those reported for the United States Corn Belt. Harrold and Dreibelbis (1951) found evapotranspiration losses from a lysimeter in Ohio from 440 to 620 mm from May through September. However, the corn growing season in China averaged only about 95 days, considerably shorter than the 150-day period in Ohio. Rhoades and Bennett (1990) reviewed experiments from various locations of different climates and reported seasonal evapotranspiration values ranging from 375 to 964 mm.

Actual (ET_a) and potential (ET_o) evapotranspiration were computed by the soil water balance equation (Zhu Zixi and Niu Xianzeng, 1987) and modified Penman equation (Pei Buxiang, 1989; Jensen et al., 1990), respectively. Fig. 4 shows average precipitation, ET_a, and ET_o for the years of the study. There was close agreement between ET_a and ET_o during the periods when water supplies were adequate. Precipitation during the corn growing season exceeded ET_a, particularly in the early part of the season. For wheat, however, precipitation exceeded ET_a only in October when the crop was sown and established. Stored soil water and precipitation combined were generally sufficient to meet the demands of the wheat crop until mid-April when ET_a fell significantly below ET_o. Hence, an irrigation at about mid-April would be very beneficial. Water-use efficiency values, expressed as grain yield per unit ET_a, averaged 1.48 and 1.94 kg m^{-3} for wheat and corn, respectively, for the 5-year period. These values compare favorably to values reported by Musick and Porter (1990) for fall-planted irrigated wheat ranging from 1.0 to 1.2 kg m^{-3}, but they also cited a number of studies reporting values of 1.4 to 1.6 kg m^{-3}, and one with an efficiency of 1.9 kg m^{-3}. Rhoades and Bennett (1990) reviewed studies on corn and reported values of 1.2 kg m^{-3} for Bushland, Texas, 1.7 for Davis, California, and 1.9 for the southern Negev region of Israel. Hence, the water-use efficiencies from the present study are at the upper range of the values reported in the literature, particularly for corn.

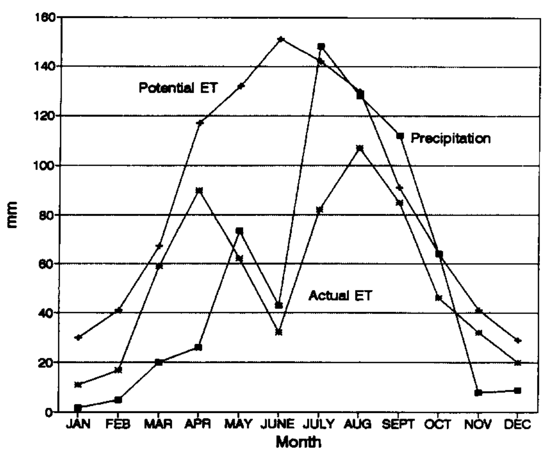

Fig. 4. Mean precipitation, potential ET, and actuala ET for 1983–1988 period at Gongxian, China.

Precipitation-use efficiency, defined as the percentage of precipitation consumed by crops as evapotranspiration, was 96.6% for 5 years of study, with annual average amount of water utilized by the two crops 616 mm and average precipitation 638 mm (Table 1 and Fig. 4). The small loss of 3.4% probably resulted from soil surface evaporation during the short time intervals between harvest of one crop and establishment of the succeeding one. Therefore, there was negligible loss by percolation of water below the root zone. Likewise, much of the cropland in this region of China is on level terraces so that precipitation is retained on the field.

Average precipitation values for the 5-year study period closely parallel the average values for the 27 years of precipitation data presented in Fig. 1. Based on these data, average rainfall from 1 October to 31 May is 201 mm, with more than 150 mm occurring in 75% of the years. Precipitation for 1 June to 30 September averaged 399 mm, with a probability of receiving more than 319 mm in 75% of the years. Therefore, the average yields for wheat and corn presented in Table 1 may be considered representative for long-term averages. Using the 75% precipitation probability value as a guideline, adequate water would be available for both a good corn crop and the partial recharge of the soil profile for the subsequent wheat crop. The probability of having extremely low corn yields such as in 1986 is low because that was the third driest summer recorded in 27 years. Extremely dry summers, however, also affect the subsequent wheat crop as clearly illustrated by the very low level of plant-available soil water at wheat sowing in 1986 (Table 1). The 4.25 Mg ha^{-1} wheat yield that resulted was the lowest in the study, despite the fact that the 210 mm precipitation during the wheat growing season was above normal. The probability of producing an average or higher wheat yield will decrease significantly in years when available soil water at sowing is below 200 mm in the 1.3-m soil profile.

3.2. Seasonal variation on soil water

The major factors affecting soil water content are precipitation, evaporation and transpiration. Because of the prevailing monsoon climate in Gongxian, the variation in soil water content is obviously governed

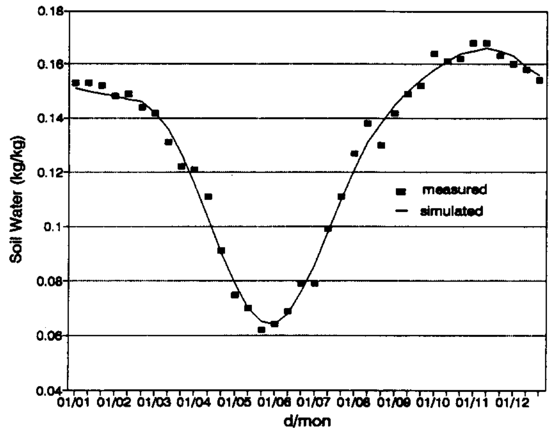

Fig. 5. Seasonal variation in soil water content at 0.7 m (average for 1983–1988).

by season. Despite inter-annual variability, soil water content basically follows a similar pattern each year. Average soil water contents during 1983–1988 at the 0.7-m depth are shown in Fig. 5. During the winter months when wheat is dormant, soil water content slowly decreases. However, with rising temperatures and a rapid increase in leaf area, soil water was depleted rapidly, which was most pronounced during the period March through May. Minimum soil water content occurred at the end of May or early June, just prior to the rainy season concentrated in July, August, and September (Fig. 1). Corn is grown during the rainy season, and the soil profile is also largely recharged with water that will be used by the subsequent wheat crop sown in mid-October. Because evapotranspiration by wheat during October and early November is relatively low, and rainfall is still substantial, water storage in the soil profile continues to increase until reaching a maximum in mid-November.

To quantitatively analyze the variation in soil water content with time and determine the water stress period in wheat and its length, the fluctuation in soil water content (Fig. 5) can be simulated by a statistical method, the multinomial sine series (Wei Shuqiu, 1985), illustrated in the following equation:

$$W_t = A_0/2 + \sum_{k=1}^{n} C_k \sin(k\omega t + \Phi_{k,0}), \qquad (1)$$

where

W_t = soil water content at the tth day in the year, expressed as kg water per kg dry soil,

$A_0/2$ = average position of function W_t in its developing range (360°),

k = ordinal number of sine waves,

n = total number of sine waves included in the equation,

C_k = amplitude of the kth sine wave,

$\Phi_{k,0}$ = initial phase of the kth sine wave (degrees),

ω = angular velocity, °/d,

t = time expressed in d.

As a function of time, ω can be expressed as:

$$\omega = 2\pi/T, \qquad (2)$$

where T = period, being one year, i.e., 365.24 days. Therefore,

$$\omega = 2\pi/T = 360/365.24 = 0.986(°/\mathrm{d}). \qquad (3)$$

Assuming $n=3$, and substituting the parameters in Eq. 1 for the 0.7-m soil depth (Fig. 5), Eq. 1 assumes the expression:

$$\begin{aligned} W_t = {} & 0.1283 + 0.04445 \sin(\omega t + 125.46) \\ & + 0.0151 \sin(2\omega t + 324.73) \\ & + 0.00576 \sin(3\omega t + 210.67). \end{aligned} \qquad (4)$$

Differentiating W_t,

$$\begin{aligned} \frac{\partial W_t}{\partial t} = {} & 0.04383 \cos(\omega t + 125.46) \\ & + 0.0298 \cos(2\omega t + 324.73) \\ & + 0.01704 \cos(3\omega t + 210.67). \end{aligned} \qquad (5)$$

Solving Eq. 5 within the range of 0–360°, the extreme value points are $t_1 = 148.18$ (d) and $t_2 = 312.05$ (d).

To determine the maximum and minimum value points, Eq. 5 is differentiated again:

$$\begin{aligned} \frac{\partial}{\partial t}\left(\frac{\partial W_t}{\partial t}\right) = {} & -0.04322 \sin(\omega t + 125.46) \\ & - 0.05877 \sin(2\omega t + 324.73) \\ & - 0.0504 \sin(3\omega t + 21.67). \end{aligned} \qquad (6)$$

By substituting t_1 and t_2 into Eq. 6,

$$\frac{\partial}{\partial t}\left(\frac{\partial W_t}{\partial t}\right)_{(t_1)} = 0.148 > 0$$

and

$$\frac{\partial}{\partial t}\left(\frac{\partial W_t}{\partial t}\right)_{(t_2)} = -0.44 < 0.$$

Therefore, t_1 is the point in time where W_t reaches its minimum, i.e., soil water was minimum on 28 May (148.18th day). Conversely, t_2 is the maximum point, i.e., soil water reached maximum on 8 November (312.05th day).

Substituting t_1 and t_2 into Eq. 4 yields $W_{min} = 0.064$ kg kg^{-1} and $W_{max} = 0.166$ kg kg^{-1}, and an amplitude $A_{0.7} = (W_{max} - W_{min})/2 = 0.051$ kg kg^{-1}. As shown in Fig. 5, the simulated curve coincides with the measured one, the absolute error being less than 0.0028 kg kg^{-1}. The annual variation in soil water content may be characterized as in Table 2:

1. Phase is slightly delayed with increase in soil depth; on average, every 0.1-m increment in soil depth lags 2 to 4 days behind the preceding depth;
2. Amplitude decreases generally with increase in soil depth; that is, soil water varies less in deep soil; and
3. The water stress period occurs from mid-April to end of June or early July.

According to other studies on the same soil, sandy loam (Zhu Zixi et al., 1987), the onset of water stress in wheat occurs at a soil water content of 0.092 kg kg^{-1}. Setting W_t at 0.092 in Eq. 4 results in $t_1 = 111$, and $t_2 = 187$. Hence, soil water content at 0.7-m depth is below 0.092 kg kg^{-1} during the period from 21 April ($t_1 = 111$) to 6 July ($t_2 = 187$), with a minimum value of 0.064 kg kg^{-1}. This coincides well with measured values in Fig. 5. Analogously, the duration of critical soil moisture content in other soil layers can be obtained, as shown in Table 3. Soil water content in the 0.3-m depth was always higher than 0.092 kg kg^{-1} because of periodic precipitation. However, soil layers between 0.5 and 1.3 m were drier than the critical soil moisture content during certain periods. The beginning of this period was delayed with increasing depth, but the duration, about 70 to 80 days, was similar for all layers.

The pattern shown in Fig. 5 is for average climatic conditions, and may vary in dry and wet years. Precipitation during the study years ranged from 396 mm in 1986, third driest in 27 years of record, to 786 mm in 1984, fourth wettest in that period. Data from these

Table 2
Parameters and results simulated for soil water in different layers of soil

Depth (m)	Parameters		Phase		Amplitude (kg kg^{-1})
			Mimimum	Maximum	
0.3	$A_0 = 0.2859$		2 May	19 Oct.	0.041
	$C_1 = 0.03236$	$\Phi_{1,0} = 144.49$			
	$C_2 = 0.0071$	$\Phi_{2,0} = 346.96$			
	$C_3 = 0.00882$	$\Phi_{3,0} = 299.5$			
0.5	$A_0 = 0.2654$		17 May	2 Nov.	0.055
	$C_1 = 0.04599$	$\Phi_{1,0} = 134.1$			
	$C_2 = 0.01148$	$\Phi_{2,0} = 335.5$			
	$C_3 = 0.00841$	$\Phi_{3,0} = 248.2$			
0.7	$A_0 = 0.2566$		28 May	8 Nov.	0.051
	$C_1 = 0.04445$	$\Phi_{1,0} = 125.46$			
	$C_2 = 0.0151$	$\Phi_{2,0} = 324.73$			
	$C_3 = 0.00576$	$\Phi_{3,0} = 210.67$			
1.0	$A_0 = 0.253$		5 June	6 Nov.	0.049
	$C_1 = 0.04265$	$\Phi_{1,0} = 122.10$			
	$C_2 = 0.01655$	$\Phi_{2,0} = 306.13$			
	$C_3 = 0.00369$	$\Phi_{3,0} = 189.76$			
1.3	$A_0 = 0.2725$		7 June	9 Nov.	0.049
	$C_1 = 0.04461$	$\Phi_{1,0} = 118.12$			
	$C_2 = 0.01559$	$\Phi_{2,0} = 299.6$			
	$C_2 = 0.01559$	$\Phi_{3,0} = 207.45$			
	$C_3 = 0.00291$				

Table 3
Duration of critical soil moisture content in different soil layers

Layers (m)	Water stress period		
	Beginning	Ending	Duration (days)
0.3	None	None	None
0.5	14 Apr.	22 June	70
0.7	21 Apr.	6 July	77
1.0	27 Apr.	16 July	81
1.3	8 May	9 July	63

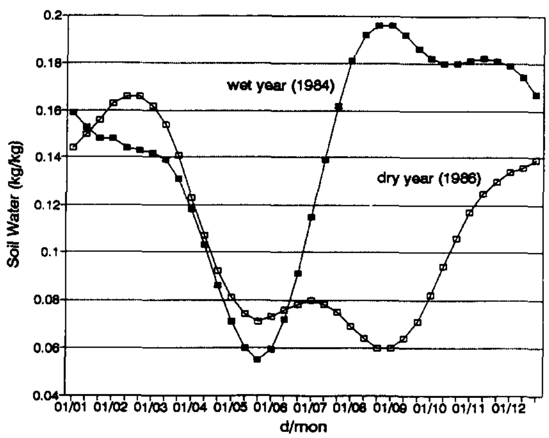

Fig. 6. Seasonal variation in soil water content at 0.7 m depth for a representative dry and wet year, respectively.

years can be used, therefore, to represent dry and wet years, respectively (Fig. 6). In the wet year, precipitation starts increasing only after July, so water stress in wheat still occurs in late spring and early summer. In the dry year, the periods of water stress occurs from late spring (21 April) through the middle of fall (10 October), lasting for 172 days and harming both wheat and corn seriously.

Four distinct periods of seasonal variation in soil water content can be distinguished:

1. The period in which soil water decreases rapidly in spring and early summer (March–June). The climatic features in this period are rapid increases in temperature and low amounts of precipitation. On average, the decrease in soil water content was 0.056 kg kg^{-1} in the 0.1- to 0.3-m layer, 0.067 in the 0.5- to 0.8-m, and 0.078 in the 1.0- to 1.3-m layer.
2. The period July to September in which soil water contents increase rapidly. Although corn is grown during this period, precipitation is sufficient to increase soil water content in the 0 to 0.3-m layer to 0.18 to 0.21 kg kg^{-1}, to 0.16 to 0.19 in the 0.5- to 0.8-m layer, and 0.15 to 0.18 in the 1.0- to 1.3-m layer.
3. In late fall and early winter (October to mid-December), soil water contents slowly decrease because of decreasing temperatures and the young wheat plants use only limited amounts of water and soil evaporation is low. Average decrease in soil water content in the period was 0.018 kg kg^{-1} in the 0- to 0.3-m layer, 0.017 in the 0.5- to 0.8-m layer, and 0.016 in the 1.0- to 1.3-m layer.
4. Soil water contents remain relatively stable during the winter period (mid-December to end of February) because the wheat is largely dormant due to cold weather.

3.3. Spatial distribution of soil water

Spatial distribution and variation in soil water content are related to soil characteristics, distribution of roots, and weather conditions. As illustrated in Fig. 7,

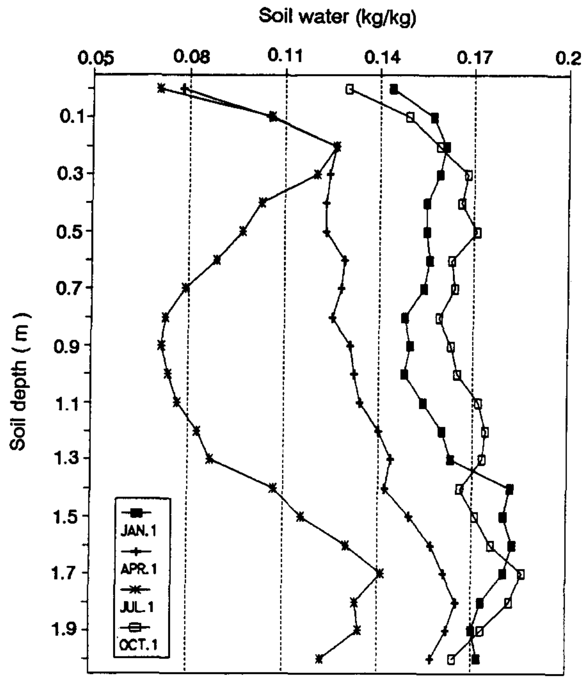

Fig. 7. Spatial distribution in soil water content (average for 1983–1988).

three soil water zones can be distinguished in the 2-m profile. Soil water content increases with depth in the 0- to 0.2-m zone because of soil surface evaporation. The vertical gradient in soil water content is 0.019 kg kg^{-1} $(0.1\ m)^{-1}$. However, it varies with season, from about 0.009 kg kg^{-1} $(0.1\ m)^{-1}$ in fall and winter, to about 0.028 kg kg^{-1} $(0.1\ m)^{-1}$ in spring and summer.

Soil water content in the 0.2- to 1.7-m zone is mainly affected by precipitation and water uptake by roots. The months of July, August, and September account for 55% of the annual precipitation. This is the period when corn is grown, but it is also the period of soil water recharge. In fall and winter (1 October to 1 January), soil water content is relatively high with two wet layers located in the 0.3- to 0.6-m and 1.3- to 1.8-m layers (Fig. 7). The vertical variation in soil water content is relatively small with a downward gradient of about 0.001 to 0.002 kg kg^{-1} $(0.1\ m)^{-1}$. Studies have shown that wheat roots reach to 0.36 m in December, 0.83 in January, 1.6 in March, and 1.9 in April (Zhu Zixi, Fu Xiangjun, Niu Xianzeng and Zhao Guoqiang, unpublished data). In early April, water use from deeper soil layers gradually increases. Soil water distribution in the vertical direction showed no great difference in the shallower and deeper layers, with vertical gradients of about 0.004 kg kg^{-1} $(0.1\ m)^{-1}$. In April to May, because of rising temperatures and rapid wheat growth, the leaf area index (LAI) reaches a maximum of 5.7 to 6.1 (Research group on crop-water stress and drought in North Plain of China, 1991). Evapotranspiration increases strongly and water stored in the upper soil zones cannot satisfy the water requirements of wheat. Therefore, wheat uses water from deeper layers, resulting in drying of the 0.5-to 1.2-m layer in July. The lowest soil water content at 0.9 m reaches about 0.068 kg kg^{-1}, close to the wilting point. The gradient in the 0.2- to 0.9-m layer is negative, about −0.008 kg kg^{-1} $(0.1\ m)^{-1}$, but is positive, about 0.009 kg kg^{-1} $(0.1\ m)^{-1}$, in the 0.9- to 1.7-m zone (Fig. 7).

Soil water content is relatively stable in the 1.7- to 2.0-m zone. There was a small negative gradient of −0.004 kg kg^{-1} $(0.1\ m)^{-1}$ showing that soil water content was decreasing with depth. The reason for the stability in the 1.7- to 2.0-m zone is the presence of a clay layer at 1.7 m that slows the downward movement of water.

Water stress during the period of April to June is not only unfavorable for grain-filling of wheat, but also for sowing corn after the wheat is harvested. For this reason, irrigation water is often applied during this period in areas where water resources permit. However, the rainy season of July through September is generally sufficient to recharge the soil profile, and the distribution of soil water content restores the winter soil water storage pattern.

4. Conclusions

The common cropping system in north China is double cropping wheat and corn. Precipitation is mainly concentrated in July, August, and September, accounting for 387 mm of the average annual precipitation of 597 mm. Variation in soil water content fluctuates periodically during the year. Phase lags and amplitude decrease with soil depth. Water stress often occurs from mid-April to the end of the wheat growing season in early June and sometimes lasts to the early part of the corn growing season that begins immediately after harvesting the wheat and ends mid-September. On average, one-half of the water consumed by wheat, 175 mm, was furnished by precipitation during the growing season and one-half, 178 mm, was derived from stored soil water. In contrast, soil water increased during the period that corn was produced. For the 5 years of the study, precipitation during the corn growing season averaged 384 mm and evapotranspiration was 263 mm. Annual average amount of water consumed by the two crops was 616 mm, and average precipitation was 638 mm, giving a precipitation-use efficiency of 96.6%. There was a linear relationship between grain yield and evapotranspiration. The average evapotranspiration was 353 mm for wheat and 263 mm for corn, with average grain yields of 5.2 and 5.1 Mg ha^{-1}, respectively. Water-use efficiency values, expressed as grain yield per unit of evapotranspiration, averaged 1.48 for wheat and 1.94 kg m^{-3} for corn.

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